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ADDRESS

DELIVERED AT THE GEOGRAPHICAL SECTION OF THE BRITISH ASSOCIATION,

NEWCASTLE ON TYNE,

DESCRIPTIVE OF THE STATE, PROGRESS, AND PROSPECTS

OF THE

VARIOUS SURVEYS,

AND OTHER SCIENTIFIC ENQUIRIES,

INSTITUTED BY THE HONORABLE EAST INDIA COMPANY THROUGHOUT ASIA;

WITH A PREFATORY SKETCH

OF THE

PRINCIPLES & REQUIREMENTS OF GEOGRAPHY:

58827
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BY

MAJOR T. B. JERVIS,

E. I. C. ENGINEERS: F. R. S.: MEMB. R. GEOG. SOC.: F. GEOL. SOC.: F. R. ASTR. SOC.: F. R. A. S.:

APPOINTED, PROVISIONALLY, SURVEYOR GENERAL OF INDIA.

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"GEOGRAPHY is not only 'the most important of the practical branches of knowledge to which ASTRONOMY is applied,' but is also, theoretically speaking, an essential part of the latter science.—In its widest sense, it comprehends not only the delineation of the form of its continents and seas, its rivers and mountains, but their physical condition, climates, and products, and their appropriation by communities of men. Astronomical Geography has for its objects the exact knowledge of the form and dimensions of the earth, the parts of its surface occupied by sea and land, and the configuration of the surface of the latter regarded as protuberant above the ocean and broken into the various forms of mountain, table land, and valley; neither should the form of the bed of the ocean, regarded as a continuation of the surface of the land beneath the water, be left out of consideration: we know, it is true, very little of it; but this is an ignorance rather to be lamented, and, if possible, remedied, than acquiesced in, inasmuch as there are many very important branches of enquiry which would be greatly advanced by a better acquaintance with it.

Our knowledge of the surface of our globe is incomplete, unless it include the heights above the sea level of every part of the land, and the depression of the bed of the ocean below the surface, over all its extent."

SIR JOHN HERSCHEL'S ASTRONOMY.

Keyword :- Travel- Surveys

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EIGHTH MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Friday, August 26th.—Fifth Day's Proceedings.

Section C.—GEOLOGY AND GEOGRAPHY.

President for Geology—Mr. C. Lyell.
(For Geography) Lord Prudhoe.
Vice Presidents for Geology—Rev. W. Buckland, D. D., Mr. J. Buddle, Mr. Richard Griffith.
Vice President for Geography—Capt. Sir George Back, R.N.
Secretaries for Geology—Mr. W. C. Trevelyan, Capt. Portlock, Mr. T. Jameson Torrie.
Secretary for Geography—Capt. Washington.
Committee—Wm. Smith, L. L. D., Viscount Cole, Sir Philip Grey Egerton, Bart., Mr. R. I. Murchison, *Gen. Secretary;* Rev. Prof. Sedgwick, Mr. G. B. Greenough, Count Breunner, Director of the Imperial Mines of Hungary, Marq. of Northampton, Mr. H. T. De la Beche, Prof. Phillips, *Assist. Gen. Secretary;* Messrs. Robert Ingham, H. Witham, Boscawen Ibbetson, J. H. Fryer, J. B. Jukes, James Bryce, Wm. Hutton, Richard Griffith, Jas. Smith, Charles W. Hamilton, John Taylor, Jun., Joseph Carne, Joshua Trimmer, Col. Silvertop, Major Jervis, E. I. C. Service, Capt. W. Allen, [illegible], Dr. Richardson.

The Vice-President for Geography, Sir George Back, on taking the chair, expressed the Meeting, and intimated that several members, for a summary of the [illegible] and objects of Geography, had [illegible] postponed on the previous day, from the multiplicity of other communications,—he would now request his friend Major Jervis, of the E. I. C. Engineers, who had passed many years of his life in India, to contribute some account of the nature of those geographical [illegible] scientific operations, which had been so liberally carried on, under the auspices expense of the East India Company. these, he felt persuaded, Major Jervis much novel and instructive [illegible]

neglected branch of knowledge, Geography; for which office, he was sure, that officer was well prepared, both from his previous conversance with its practical and theoretical details, and his proper professional education. Other particulars, no less interesting and important, in reference to the various Surveys throughout Europe, and generally in all quarters of the globe, would be communicated to the Meeting, by Mr. G. B. Greenough, Capt. Allen, R. N., and Capt. Washington, R. N., who had laboured so indefatigably in a cause, which equally concerned the National honor, and the Commercial interests of a great Maritime people. Major Jervis then addressed the Meeting, as follows.

Mr. President and Gentlemen,—It is with some diffidence I venture to address this large assembly on the subject of the Survey of India, and the Geography of those vast and interesting regions, in which I am destined to direct the important geodetical investigations for the determination of the Earth's figure, and other physical and geographical enquiries. The general principles of Geography I could wish to see better explained, and the utility of this science more ably asserted.

The present circumstances of India, and its peculiar relation to Great Britain, are sufficient of themselves, in these critical times, to constitute a claim to the attention of the mother country, and of every intelligent and christian mind: to call forth in us who now plead the cause of Geography, and in every individual whose lot may be cast, or whose public duties may be engaged in that remote quarter, the most energetic activity, and the most devoted application of our best powers:—Geography in short,—[illegible] secondary object in this Section, is, pro[illegible] Geography its principal and by far the most important [illegible] inasmuch as it stands in respect to

the things of this earth,—to *Terrestrial phænomena*, of whatever nature, precisely in the same circumstances as Astronomy to *Celestial phænomena*.

Astronomy and Geography may be appropriately styled Sister Sciences. These are the two rich depôts of facts to which all other researches contribute, the grand repositories to which such facts are eventually and necessarily referred,—where they should be so distinctly classified and disposed, and in the last resort so harmoniously combined, as to present one comprehensive intelligible whole; thus fulfilling in conjunction, the true intent of such pursuits: to methodize and simplify other compendiums of physical knowledge, to bring their various details within the reach of our limited capacities and short existence, to make us better acquainted with our own constitution and abode, and the great Author of all things,—to make us, in short, more reasonable, more contented, and more humble. Summarily, to deduce and appreciate the unity of design of all objects and phænomena with which they are conversant, and so to trace, in the laws of either science, that character which is so strongly written thereon, of order, obedience, and all-wise goodness.

Whether we wing our flight to the boundless realms of Planetary space, or confine our observation with microscopic scrutiny to the minutest objects of the Globe we inhabit, we are fain to acknowledge with reverence and delight, the power, the wisdom, and the symmetry which pervade Creation; we thence discover and feel our relative situation and obligation to that great Power whose fiat gave law to their existence, who [illegible] continuance or modification; of "the [illegible] beyond His control, of the least as not [illegible]"

To [illegible] from the lips of the [illegible] the Chemical an[illegible]

tion, (Mr. Whewell,) the words which he addressed to you last evening, "it is not that we pursue science because it is an instrument of power, or selfish gratification,—we love it for its own sake;"—even as Truth, and the Source of Truth, is loved; because it is conducive to our mutual edification and happiness, and as such therefore entitled to our highest regard: we are thus led to see its value as our necessities thicken upon us; and this, I take it, is the genuine character of all those attachments,—I speak as a member of society, and with reference to the endearing ties of domestic life,—this is the genuine character of all those attachments which gladden and humanize our existence: to grow with the perception of their moral excellencies, in exact proportion as our experience of the advantages, the suitableness, and the obligations, attendant on their cultivation, is improved and strengthened by time. It is in this kindred spirit therefore that we must rightly appreciate and study the comprehensive views of Geography and Astronomy: since we have now arrived at a period when a far more enlarged acquaintance with these sciences is imperatively requisite, to keep pace with the more extended intercourse and growing civilization of the age.

I would not be misunderstood, however, by those whom it is now my privilege to address, by some at least who may possibly have got their ideas of Geography from the miserable publications,—most puerile compilations indeed are the very best we have, although professing to treat fully of this subject. I would not have it supposed, that Mathematical Geography is a mere confused aggregation of concepts, and hypotheses, and diagrams, tumbled together: of outlines of countries projected without any regard to geometrical [illegible] systematic orthography, to object,

scale, or taste, as too many of our Maps and Charts are; nor coarsely, and carelessly scored, with wavy zigzags to indicate rivers, and certain rude scratches the *universal* representatives of mountains, or rocks, although differing essentially from each other in height, character, composition, and stratification; neither would I have it understood, that Descriptive Geography consists in the usual meagre narratives of personal adventure; a sort of conglomerate,—my Geological friends will pardon me for appropriating a term from their heterogeneous nomenclature;—an *omnium gatherum* of particulars, imperfectly and negligently ascertained, and still more wretchedly put together: I would have it reduced to such precision and clearness, to such method, taste, and expression, to such judicious and intelligible distribution, under the several heads of Physical, Statistical, and Political Geography, as should acquaint the enquirer, *at a glance*, with the most remarkable features and circumstances to which his attention should be, or might have been directed. The Maps of such a system of Geography should present a striking Pictorial summary; the Memoirs, a complete Descriptive analysis, of every circumstance which can elucidate such subjects.

But, if this degree of perfection be thought unattainable, I would still draw the attention of the Geographers of the present day, to the words of D'Anville—addressed some sixty years since to the Academy of Sciences at Paris,—"Dans l'universalité de l'objet qu'embrasse la Géographie, combien sont étroites les limites de ce qu'on peut attendre de cette Géographie positive? Combien de points de vue différens, qui rendent la Science intéressante, lui sont étrangers? Si le desir de n'avoir de Géogra[illegible] seroit en quelque manière l'en[illegible] peut être qu'une chimère, n'est-[illegible]

chercher à se procurer ce qui peut y suppléer jusqu'à un certain point de perfection? Neanmoins, si on ne pense pas que la Géographie soit une Science de pure erudition, c'est ne la pas connoître. Quelque, notions de la Sphère et d'une Tequenique, qui dans un Art donne des principes d'opérations pratiques, sont peu de chose en comparaison de ce que le savoir en Géographie, par un détail presqu'infini, doit rassembler de connoissances."

The most experienced of my scientific friends, whom I now see around me, will agree with me that Geography is at least a *progressive science*, and in this respect also, like Astronomy, is continually improved, rectified, and illustrated, by more exact observation,—and by further physical discoveries.

How much other branches of knowledge depend upon, or result from similar principles, can only be inferred from a review like that I have now epitomized. It is to the true figure of the Earth that we must look for an accurate acquaintance with the motions and distances of the planets. Geodesy supplies a base line, by which to determine the relative position of those distant orbs, and expound the primary elements of physical astronomy: it is, in fact, by recourse to the details we offer, that every problem of practical utility is reduced to positive certainty. In another Section, the Physical and Mathematical, some of my hearers may probably remember an anecdote related of the celebrated Franklin, by our President, Sir John Herschel, importing that the world were indebted to a landsman for the discovery of the art of navigation. Now, one or other of these two elements, Land, or Water, must be accurately defined; that boundary then, was assigned by Geographers. To our naval observatories indeed, both Seaman and Hydrographer owe their astronomical and chronometrical

observations,—while the conformation and height of the cliffs and mountains, skirting the ocean, are recognised as the most unequivocal indications of the part submerged,—of the bed of that ocean on which he is to cast his anchor; to coast, as inviting his peculiar craft; or to shun, as otherwise dangerous of access.

Every Nautical observation possesses an interest, so far only as it is connected with terra firma, the proper abode of Man:—at the same time, the medium by which a more extensive intercourse is facilitated between the remotest parts of the globe, furnishes a conclusive argument of the intimate connection between Geography and Astronomy, since this last is the science which mutually determines the boundaries of land and water. And indeed, whatever qualifies, or affects those great Laws of temperature, of the winds, of the tides and currents of the ocean, is attributable to the quantity, to the form, and to the elevation of the land, with respect to the fluid by which it is surrounded; joined to its situation in respect of the Equatorial and Polar regions:—for all these would otherwise be extremely simple, and uniformly explicable, admitting that the outline, elevation, and proportion of the land had been otherwise than it now is.

Hence, therefore, the Geologist is absolutely dependant on accurate Geographical data for all sound and rational conclusions, explanatory of those remarkable proofs of a warmer temperature in high latitudes, indicated by the fossil remains of many extinct species of animals and plants: and although we might aver, from analogy, that they could only subsist in tropical climates, we deduce the probability of such change of temperature, by reasoning from facts within our reach; facts which are so [illegible] intelligible, and conclusive, as [illegible] rate geographical and physical [illegible]

much also, as these circumstances determine the habitation of plants and animals, and all work together to break up and prepare the crust of the earth for the sustenance and abode of man,—it is to a better acquaintance with these particulars that we are to look for the extension of those enjoyments and limits, which the earth is calculated to afford to increasing numbers, to the demands also of progressive civilization.

The Geologist finds every improvement in Geography furnish new matter of study and speculation; the Meteorologist, the Botanist, and the Zoologist, ultimately defer the generalization of their researches to that exact geography for which we now contend: to arrest the progress of the latter, is undoubtedly the greatest hindrance to the philosophical cultivation of every other branch of Natural History. I have thus thrown together my own ideas of Geography, and stated its amazing importance to the lovers of science—"une science," says Danville, "qui est infiniment utile sous quelque point de vue qu'on la considere," But it has yet another and more grand attraction for those who study it as illustrating the theatre of events that have long passed away, or holding out to the Statesman and the Philanthropist a rational prospect of the capabilities of regions as yet imperfectly explored, the scene perhaps of future achievements, when the human race shall have greatly multiplied beyond its present numbers,—nay, more than all, when every corner of the earth shall be brought, throughout its length and breadth, under the power and spirit of the Gospel.

Vainly do we contemplate the changes which have supervened, or but faintly perceive in the page of the historian that instructive "philosophy which teaches by example," if unacquainted with the geographical, and physiographical divisions which then influenced

the movements of society, which now at length we surely might have anticipated from the progress which has been made in other matters. The site of Babylon, of Nineveh, of Idumæa, of Oojein, or of Troy,—the sources and course of the Euphrates, the Niger, or the Indus,—the former limits of the Caspian, the Indian Run, and the North American Lakes,—might possibly throw a degree of light on the early migrations of society, which are now veiled in the darkest obscurity, from our imperfect knowledge of Geography. To the neighbourhood of the former, and the mouths of the Euphrates, our sympathies are called to numerous simple tribes, who profess no other baptism than that of St. John, the precursor of our Lord. To Mosul, the seat of ancient Nineveh, the Christian world may look for the recovery of those numerous Christians, the Nestorians and Chaldanees, to the tenets and blessings of a purer faith, which now they desire to recognize in common with the Church of England. The very difficulty of pointing out the exact site of those great cities that have perished, and "whose memorial has perished with them,"—confirms and gilds the prophetic page. It tells what the inhabiters of earth have been, it tells what they will be.

Shall we then leave the Missionary uninformed of all the encouragements which this or that country presents, for the dissemination of the gospel? Do we imagine that any sums of money collected here, or any number of men sent abroad, without a knowledge of the climate, the people, or countries they go to, can civilize and bring over the helpless besotted Heathen to a sense of the value of Christianity, if we omit to entertain the precautionary measures which science should dictate, by which his health and [illegible] should be provided for, and his opportunities [illegible] enhanced? I remember to have heard [illegible]

and faithful Missionary, the late Rev. Gordon Hall, observe, on hearing of our vast territorial acquisitions in Burmah, that "we were not to think these conferred on the British Crown without a purpose; that he was sure this was the highest it could have been entrusted with,—to propagate there the privileges of sound religious liberty, and a pure faith,—so that the border nations of China and Siam, inaccessible from other quarters, might in some sort, through their ministry, participate likewise in a common benefit." It is fair to conclude as much of Science, nor can any reflecting mind look on the strides it is now making, and imagine it is permitted to advance without the same All-wise intention. Subserving the important purpose of exploring the darkest recesses of Nature, it should also light up the darkest retreats of Humanity. Nay my friends, if we really desire success to the one or to the other, to Science or to Missionary enterprise,—we must first improve Geography.

Having said thus much as to my individual views of Geography, I revert to the other subject which it devolves on me to explain,—the nature and progress of the various Surveys carrying on under the authority of the East India Company. They extend to no inconsiderable portion of the shores, and undoubtedly to the most valuable and promising region of Asia. I need not say much as to our acquisitions in that quarter:—we acquired them chiefly by the instrumentality and prowess of Clive; for he laid the foundation of those fortunes which have been followed up, as he foresaw, by successive additions to our power, till we were at length undisputed masters of India. Whosoever is desirous to know more of our early conquests, will do well to study them, elegantly and faithfully as they are narrated by our own Historians, Orme and Malcolm, or reasoned by Mill, from those rich and

voluminous records, which have been communicated by our countrymen in India.

From the elaborate and philosophical work of Mill, the reader will infer, that however much we owe to the individual bravery and discipline of a mere handful of soldiery, we are largely indebted to that disunion, to that entire extinction of all patriotism, good faith, and private virtue, which is ever consequent on despotism, ignorance, and superstition. Let him contrast these conquests with those of the Spaniards and Portuguese in the new world; with those of the Romans in a former age, or of the Mahomedans in after times; —he will then understand whence power is acquired, and by what errors the sword of the victor quails to the meanest adversaries.

What memorials, he will naturally enquire, have these nations left in all their colonies? where also are the characteristics of their superiority?—Do *we* contemplate any enduring memorials of the British ascendancy,—it must be in such as are characteristic of the British people:—the diffusion of *sound education;* —the administration of *just laws;*—the *improvement* of the resources of the country, and the condition of the people;—the *introduction* and *promotion* of those arts, sciences, and conveniences of life, which distinguish and enrich our own;—the *encouragement* of commerce;—the *unrestricted* interchange of manufactures and produce, not only beyond the boundaries of our territories, but within, and through every province. All these objects, however, [illegible] only be anticipated from a thorough acquaint[illegible] nature of the country, and of the peopl[illegible] notwithstanding, such as are at the mil[illegible] of the Government of India, far [illegible] have ever been possessed by any [illegible] indeed, a more moral, efficient, [illegible]

of men, could not be instanced than those which compose the Civil and Military Services of the East India Company;—the Executive, and the Soldiery, by whom that great Empire has been subjugated, and is still maintained. In the Engineer profession I presume there are sufficient officers, perfectly competent to the great undertakings which are so much required to throw open and improve the provinces in the interior, by the construction of roads, canals, and great public edifices. There is also no want of wealth for such designs, in which I know the Natives would gladly participate, under proper protection and encouragement. I will defer these topics, however, to the notice of our geographical acquisitions.

You have heard, at our previous Meeting, from Major Portlock of the Royal Engineers, who is employed on the Ordnance Survey of Ireland, that we are principally indebted for the British, as for this, and most Surveys, to the exigencies of war. The scope of such Geography was then limited to specific wants, to bring under one view such materials and information as would facilitate the distribution and concentration of troops,—or the ready supply of necessaries for their subsistence. It has undergone no material change from its imperfect state in those early times, when the Military art was first reduced to some sort of system under the Romans, till the middle of the 18th century. The Maps of that period were, generally speaking, mere Itineraries, having more or less accuracy as they were corrected by frequent astronomical observations, or founded on actual measurement.

In this state of things it was reasonable to expect that some information would be obtained of those parts of India which had been traversed by our armies. In 1760, the want of such Maps became apparent

to the Government of India, and no pains or expense were neglected to procure the best materials that could be had. The industry of Col. Charles Reynolds furnished a surprisingly exact outline of the Western part of the Peninsula, and a considerable portion of Hindoosthan,—compiled chiefly from native information,—corrected at intervals by the latitudes and longitudes of the most remarkable places on the coast, which he obtained from Captains Mc. Cluer, Huddart, Howe, and other Naval Officers.

But I should not do justice to this subject were I to pass over the names of my distinguished predecessors, Reuben Burrowes, Colebrooke, Major Rennel, and Colonel Mackenzie, and to crown the list of these, the names of Lambton and of Everest. To the two latter we are indebted for all that is worthy of note as regards Geodesy, or the purely scientific department of the Indian Survey;—to Rennel and Mackenzie we owe the best and largest share of our geographical and statistical information. Of Major Rennel you have all heard;—He was the first and greatest Geographer that this country has ever produced. With a mind singularly constituted to elicit and apply every useful fact,—like the illustrious Danville, he selected his materials with such extraordinary judgment, and arranged them with such tact, that the positions he has assigned to many important places thoughout India, from data, that would to most of us be inconceivably perplexing,—agree in a very remarkable manner with the results of astronomical and geodetical observation. Nor did this [illegible] or skill, stop here.—His beautiful [illegible] the Retreat of the Ten Thousand,—[illegible] and of Xenophon, are familiar to many [illegible] light he threw on the obscure notices [illegible] relative to the interior of Africa, is still [illegible]

admiration;—and lastly, his remarks on the Currents of the Ocean entitle him to our respect as a philosopher, in whom were met those rare accomplishments essential to generalize insulated facts. Of Colonel Colin Mackenzie I could say much.—His was the faculty of combining Statistics with Topography,—of subjecting all the details of Surveying to a methodical analysis,—so as to present a connected digest of the resources, the situation, and the history;—to which last pursuit, more particularly, the Ancient history, he paid very great attention. There are others, Topping, Col. Kelly, and Moncrieff, but I will pass on to Lambton, and here I must make a short digression.—You have been accustomed to expatiate on the merits of the Duke of Wellington as a Soldier and a Senator, yet there are endowments in that great man which are not sufficiently known. Whoever will be at the pains to criticize the early correspondence of Colonel A. Wellesley, in India, by Colonel Gurwood, and in Gleig's Life of Sir T. Munro, will agree that his was always a gifted mind,—a mind which could single out and appreciate talent, arraying in anticipation the prospective advantages which would accrue to his country by the appliances of science. This was it which induced him to befriend Lambton, then one of the officers of his own corps, and to recommend his suggestions to the Marquis Wellesley, Govr: General of India. An embassy having been sent to China by the British Government, it was supposed, as the Chinese prided themselves on the high antiquity of their Astronomy and Mathematics, that the Grandees of the Celestial Empire would be glad to have some good astronomical apparatus; whereupon, a fine theodolite, a sector, and a steel chain, similar to that used by General Roy in the measurement of the bases of the Survey of Great Britain, were dispatched as pre-

sents; but the Emperor declining to see our Ambassador, Lord Macartney,—these valuable instruments were brought back and put up to public sale at Madras, by Dr. Dinwiddie, Physician to the Embassy, to whom they had been assigned by Lord Macartney, in part compensation for his services. At Lambton's suggestion they were purchased on behalf of Government, and with them the measurement of an Arc of the meridian, in India, was first undertaken by that officer.

This useful and laborious work has been carried on from that time, 1800, to the present, by Colonel Lambton and Colonel Everest. The former died on his post, in 1823, at Hingungaon, at the advanced age of 73,—his energies carrying him through to the very last;—an example of that philosophic devotion which unites patience and energy with a high degree of intellectual ability. I may be pardoned for reading to you a short extract which I made from the last report he ever wrote.—It is touchingly expressive. "It is now upwards of twenty years since I commenced the Survey on this great scale. These years I may venture to say have been devoted with unremitted zeal to the cause of science, and if the learned world be satisfied that I have been successful in promoting its interests, that will constitute my greatest reward. In this long period of time, a considerable portion of the life of man, I have scarcely experienced a heavy hour; such is the case when the human mind is absorbed in pursuits that call its powers into action:—a man so engaged, his time passes on insensibly, and if his efforts are successful, his reward is great, and a retrospect of his labours will afford him [illegible] gratification. If such should be [illegible] my career with heartfelt satisfac[illegible] with unceasing delight to the y[illegible] India." This grand scientific [illegible]

Colonel Lambton's death, embraced an amplitude of 11 degrees from Punnae, in 8 degrees North latitude, to the frontiers of the Peninsula, has been subsequently continued with unwearied resolution and ability, by Colonel Geo. Everest, and is now on the eve of completion, as we learn by recent letters:—in these he announces that the whole of the terrestrial operations have been successfully brought to a close, some few additional celestial observations only remaining to complete the greatest, and, probably the most accurate, service of the kind that has ever yet been accomplished or attempted in the annals of science. This encomium will be fully admitted when we consider that it comprises a total amplitude of about 23°, or nearly one sixteenth of the entire circumference of the globe. Two series of triangles diverge laterally from the main trunk, connecting Bombay and Calcutta; added to which, about three fourths of the Peninsula, and several collateral series, on as many distinct meridians, throughout the lower provinces of Bengal, have placed the exact site of many considerable towns in British India beyond a doubt.

The connection thus established between the the Observatories at the principal seats of Government, the chief resort also of our navy, supplies a most important desideratum in Geography, which will no doubt, under judicious provisions, contribute very materially to the correct determination of the latitude and longitude of many other ports and dangers on the shores of Asia. More in fact is to be gained in Hydrography, as I have already hinted, by establishing the true place and bearing of a few fixed Observatories on terra firma, simply as starting points, than from a thousand unconnected, or disputed points of departure. For this reason we cannot contend too earnestly for the repeated verification of these posi-

tions; they serve as it were for a basement on which to rest the entire superstructure of Nautical and Geographical Surveys; they constitute, in fine, a sort of half-way house between the earth and heavens, to which any phænomena may be referred, or by which any changes, either in the celestial worlds, or this planet, can be satisfactorily registered, and ultimately determined.

The Maritime Surveys, which have been made by the East India Company's Naval Officers, are honorable to the spirit of that great public body, at whose desire they were instituted. A series of Charts of the entire coast of China, by my friend Captain Daniel Ross, I. N.; and others, illustrating the ports, rivers, and coasts, from Cochin China, and throughout the Malayan Archipelago to the confines of India, by Captains Crawford, Robinson, and Ross,—are highly useful to the navigators who frequent those seas. A comparatively small expense and exertion would, with such materials, put the Indian Government and the public, in possession of the principal geographical features of that long and narrow peninsula which stretches to the South-east of our territories;—probably also open out many valuable sources of commerce; by establishing also a friendly interchange of produce, paralyze, or put down, those piratical aggressions which preclude the civilization of the Eastern Islands. The Surveys of the Persian Gulf and the Red Sea, by Captains Maughan, Brucks, Haynes, and other officers of the Indian Navy, have been undertaken at great charge, most opportunely indeed, for the furtherance of steam communication between this country and India.

The recent Surveys of the Maldives and Laccadives, by Captain Moresby, will probably elicit some interesting particulars relatively to the formation of those coral reefs which abound in the Indian Ocean. The

changes which have taken place within the last century both on the Eastern and Western shores of India, lead to the conclusion, that many stupendous alterations in the form and depth of the waters on the coast are now in progress;—tending to evidence the recession of the ocean on the one hand, and its encroachment on the other. This, in my opinion, is particularly the case in respect of the neighbourhood of Bombay, unquestionably one of the finest harbours in the world. The fact of such change has been made the subject of a warm and most unsatisfactory discussion between the late Admiral Sir R. King and the officers of the Indian Navy. Such inferences however will be more speedily arrived at by an examination of the Gulf of Cambay, the increase of the Deltas of the Indus, Godavery, Ganges, and Bruhmapootra, and the effects consequent on the opening of the Paumbum passage, between the Island of Ceylon and the main land. In the Bore of the former, to which the public attention has been drawn by a paper of Lieut. Ethersey, I. N., there is a novel and grand opportunity for deducing the law of waves, which has been handled in so masterly a manner by Mr. Russell and Sir John Robinson.

In pursuing the multiplicity of researches which thus obtrude themselves in a Hydrographical Survey like that under consideration,—there is ample scope for the most indefatigable and ardent mind,—the variations in the form of the coast; the progress of coralline formation in the Red Sea, the Maldives, and Laccadives;—the quantity of detritus yearly brought down to the sea by the Euphrates, the Indus, the Nurbhudda, Kavery, Krishna, Godavery, Ganges, Bruhmapootra, and lastly, the Irawaddi;—the increase to their Deltas;—and the proportionate velocity of their currents to the respective length and fall, with the

quantity of detritus held in solution, or deposited from time to time:—Such investigations, simply in reference to their respective geological bearing and tributary streams,—open out an indefinite field of the very highest interest to science.

There are the tides of the Ocean moreover, which, apart from the important bearing of their laws on Physical astronomy, are most necessary to be well understood for the construction and maintenance of docks and harbours,—the preservation of embankments, the deepening of river beds, and in short, as the best pledge, or criterion for the undertaking, or discontinuance of great and expensive Maritime works.

I should be sorry to have it concluded, by any persons here present, that I had merely introduced these remarks in a loose speculative way, for the sole purpose of garnishing my observations.—I have, at various times, considered the subject with deep attention, during a long residence in India,—and with Smeaton's reports, of what has been done in England, with Prony's and Cuvier's of those on the Continent, I have satisfied myself that the changes now in course of exhibition, on the Western coast of India, absolutely invite the most improvident and apathetic Government to take possession of, and bring under cultivation, enormous tracts of rich alluvial land, capable of sustaining a dense and industrious population. I observed this more particularly in the islands of Goa and Salsette, the habitable parts of which, four centuries ago, must have been circumscribed within very narrow limits: but it is exemplified throughout the entire coast from Bancoot to the Mahee river, in Goojrat; more particularly on the shores of the Northern Concan, and Attaveesee provinces. These particulars I have frequently brought under the cognizance of the Bombay Government in my professional reports. It may be

they will one day receive that attention which the mere produce of such undertakings would warrant them to encourage.

I will here remark, cursorily, that the Natives of India, and many enterprising Europeans, would gladly avail themselves of the grant of such lands, with suitable inducements, and embark capital in their recovery or improvement;—but I would advise these grants to be tantamount to Freehold, and, for security, require that the execution of such works should in all cases devolve on professional Engineer officers. These should be responsible for the design, and the due execution of such undertakings,—the entire charge and profit that of the parties to whom the grants were assigned, on such express stipulation. Then indeed the Government would see India prosper:—In regard to roads, and some public works in the interior, further privileges might be enacted, which should invite their execution, and ensure a reasonable and timely return of interest and capital;—in which last case they should, thenceforth, be the property of the community. I have put this desire of the wealthier natives, to co-operate with us in such measures, to the test, in three instances:—and am confidently persuaded from experience, and their own affirmation, that it is an effectual substitute for that careful and straitened system which Government has hitherto pursued in all undertakings, however desirable, involving a large expenditure.

The construction and delineation of these Charts does very great credit to the taste and ability of Captain Houghton, who has been employed in that duty throughout, both in China and Arabia. In regard to several of the Maritime Surveys, I confess I have learnt with astonishment, that there exist few, in some cases, absolutely no written memoirs: that they have either been retained altogether by the officers who conducted

the Surveys, or deposited in some of the offices in India, to the great detriment of the public interests. The Survey of the Red Sea and the Persian Gulf requires very circumstantial explanatory memoirs for navigators, especially in the event of renewed piratical hostilities; but the meagre particulars that are to be gathered from the papers which have been sent home, ill accord with the charges, and the time, that have been devoted to their execution:—the height of the lands skirting the coasts has been unfortunately omitted, and the want of a better mode of expressing the form and character of the ground within sight of the navigable shore, is much to be regretted;—but these deficiencies are wholly attributable to the imperfection of this most necessary accompaniment of Hydrography, as well as Geography. Systematic, consistent, and correct orthography, founded on a studied acquaintance with the proper language of the country, adds very much to the utility of a chart;—the tabulated direction of the winds and currents that are most prevalent;—the isoclinal lines of soundings also, lead to the recognition of a thousand facts of considerable use. But on these points I have dwelt perhaps at greater length than my Naval friends will consider allowable.—I shall briefly state, therefore, that the investigation of the Tides, has, at the suggestion of Professor Whewell and myself, been most liberally and effectually taken in hand by the East India Company, and as it may eventually devolve on me to give effect to their intentions, I engage it shall be in full accordance with these views, and those generally entertained by the British Association.

The geographical and topographical details of the Indian Survey have been carried on, since the year 1759, at an expense little short of one million four hundred thousand pounds, as I was credibly informed by the late General Salmond, for many years Military

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Secretary to the Court of Directors, E. I. C. From what I have premised respecting the Trigonometrical Survey, it would have been reasonable had more than ordinary attention been paid to the mere execution of the Topography. I wish I could say that it had any claim to comparison with that of the recent surveys of Europe:—I will candidly explain to you what I consider the occasions of its inferiority, not without hope that they may, and will, shortly be removed, convinced as I am that there is every disposition in the home authorities to forward any measure which may be calculated to realize the *public entreaties* for its improvement. I am justly proud of succeeding to an office which has been so ably filled by Rennel, and Lambton, and Everest. I have not been inattentive to this branch of my profession, in which I have served twenty-three years, and indeed, during thirteen, have been employed on the Survey of the Western Coast. I do not hazard any conjectural ideas therefore; nor assert, without a thorough examination of all the documents that have yet reached this country, that we are immeasurably behind the people of Europe, in this most useful of all sciences.

For forty years, despite of such men as Reuben Burrowes, Rennel, and Mac Cluer, the Surveys of India were little better than Roman Itineraries,—and so deep rooted was the prejudice in favor of the system of measuring with an ordinary perambulator and magnetic compass, that the utility or necessity of any such corrective, as that proposed by Lambton, in a connected Triangulation, was very generally controverted. It was only by the intervention of repeated injunctions from home, suggested, very much to the honor of the Court of Directors, by their late Military Secretary, that this triangulation was suffered to proceed. Prior to the commencement of such operations

Major Rennel, of the E. I. C. Engineers, was the only one who can be said to have thoroughly understood the requirements of Geography,—but in this he stood quite alone, and his philosophical views were neither understood nor adopted by his immediate successors; or, we might now, have as far outstripped the Geographers of Europe, as then. The Memoir which accompanied Rennel's Map of India, is to this day a standard work,—an honorable proof of his industry and judgment. It will hardly be credited however, that the *original surveys* of the lower provinces of Bengal and Bahar, which he made single handed, and from which the printed Atlas was reduced, were brought home by some of the high authorities in India, and treated as *private property*, till they were accidently discovered, in the collection of a lady of rank, by General Salmond, and, with his advice, were purchased for the sum of one hundred pounds, by the Court of Directors. This incident, with others of a similar nature, may serve to show how very little some men understand the use or the public importance of such documents. Much knowledge is undoubtedly abstracted, hoarded up, or lost, from the selfish vanity of possessing a rare or unique article, which would be far better communicated to the public. That propensity, however, we confidently hope has no advocates amongst men of science.

The want of similar memoirs to that of Rennel, something at least, explanatory of the principles on which the respective Surveys were constructed,—has occasioned the greater portion of such documents to be altogether valueless:—and in most cases to serve rather to perplex, than to assist, persons unaccustomed to the critical compilation of such works. I would lay it down, therefore, as a rule, that no survey whatever, should be received, or entitled to publication,

without such documentary credentials of its authenticity. It is clear that these were the maxims of D'Anville and Rennel;—and it is the first effectual step towards correct and scientific Geography.

A further occasion of the backward state of Indian Topography was that want of system and uniformity, in the Style, Orthography, and Scale of the respective surveys. Each Presidency had its own school, and in many cases each individual followed his own fancy, so that the materials from which the Atlas is now compiled, differ essentially in all these requisites:—it will be thought unaccountable also, that the Trigonometrical and Geological Surveys, should have been kept quite independent of the Surveyor General's controul, from their very commencement, till 1823. This anomalous procedure had not escaped the notice of the Military Secretary and Colonel Everest,—at whose recommendation these several duties merged in the Surveyor General:—still the Revenue and Statistical surveys remained quite distinct,—and were so till very recently, if indeed the orders of the Directors have yet been carried into effect;—so that the very materials which should best supply that more perfect and valuable Geography, are separately prepared, and what is worse, they are obtained at an enormous cost to the Government, without any permanent utility, or connection, with the general triangulation of India. All officers who have had experience in these matters in India, and many distinguished persons in this country, concur with me, that every survey which is not the result of science and system,—is so much positive sacrifice of time, money, and life;—a prodigal and unjustifiable waste of public property,—which needs but to be properly represented to be obviated in all time to come.

If the object of a survey were of some tempora

nature, or of limited application, such course might suit, in some instances, both the purpose and the public purse;—but when we compute the sums disbursed, and set them against what we have now to show for such outlay,—with reference to the general applicability of a good survey, on a sufficiently large scale, accompanied by explanatory memoirs, to the *ordinary* wants of Government, the case is one of the greatest extravagance and inexpediency. The conclusion I press upon the authorities, is, to collect together *all* the materials that we now have;—to retain those only which are deserving of it;—then to proceed with all the helps we have got from past experience,—resolutely ordering all such steps with the strictest regard to economy, so far as it consists with the claims and requisites of science. In fulfilment of this plan, some discretionary powers in the choice of the machinery, the selection of the officers, and general management of the details; a much larger share of responsibility, in short, must necessarily devolve on the Director;—but, I am sure, it is a responsibility which no man, who has the slightest pretension to science or character, would either vainly arrogate, or wantonly abuse. His reputation, his success, his interest, depend on the issue of his suggestions, and that essential confidence will I trust, at length, be placed in the officer who has been provisionally appointed to succeed to the Surveyor Generalship of India. It is to this implicit confidence that we are indebted in this country for the great improvement in the Admiralty and Ordnance Surveys, under Captain Beaufort, R. N., and Colonel Colby, R. E.: the same powers also have been delegated to the Director of the Depôt de la Guerre in France, General Pelêt, of the Corps du Genie; and to all the Directors of the great Continental Surveys of Austria, Saxony, and Russia, Colonels

Schriebenach, Oberreit, and Schubert. It is but reasonable therefore to conclude, that very weighty reasons have prevailed over other considerations, in a country where every avenue to patronage is so jealously guarded and circumscribed;—reasons, dictated by universal experience, and the greater efficiency of the public service.

Without entering into any more particular consideration of the several provincial surveys, I shall only observe, in a very general way, that the Madras surveys, under Colonel Mackenzie, and his assistants, Captains Garling, Ward, Connor, Mr. Turnbull, and other officers, bespeak an anxiety to forward the objects of the public service, and of Geography, which is highly commendable. The Surveys of Hydrabad, Tritchinopoly, and the Northern Circars, are great improvements on the earlier surveys, yet they are not so complete as those of Mysore, Malabar, Goa, and Travancore, in Statistical and Descriptive memoirs. On the whole, however, these surveys are very inferior, in topographical detail and expression, to the continental geography of Europe. Whatever merit they possess, is principally owing to the master spirit and direction of Colonel Mackenzie, and, under his orders, to the instruction of Captain Troyer, and the Madras Military Institution.

The Surveys of the Bombay Presidency certainly rank next. That of Bombay and Salsette, by Colonel Dickenson and Captain Tate, of the Engineers, surpasses every other throughout India, in accuracy, elegance, and completeness. It is allowed, by the first judges in England, to be one of the most beautiful specimens of Topography that they have seen. It was accompanied by a very detailed statistical memoir. Major Jopp's Surveys are admirable in the general expression, but they are not accompanied by any memoir, either of their construction, or physical and

statistical details:—the scale also is not sufficiently large to admit of such illustration; or, in truth, for any civil purpose, beyond an acquaintance with the actual bearing, and distance, of places from each other, and the relative situation of the mountain ranges, passes, and rivers:—beyond this, whether, Forest, Cultivation, or Waste; whether Rocky, Productive, or Populous, we can infer absolutely nothing,—and the same remark, I regret to say, was precluded, in the Survey of the whole coast, from Goa to Duman,—by the strict injunctions to reduce the scale from two inches to the mile, on which it was first laid down, to half an inch to the mile; just one sixteenth. In this latter survey, however, I have shown in separate maps the Geographical distribution of the indigenous plants, the Statistics of Revenue, Commerce, Education, Industry, Crime, Slavery, Religion, Language, Caste, and general Distribution of the population,—amounting to about 1,200,000 souls. These maps were retained in India; but, as I have now a much wider field to explore, I hope to extend the illustrations of this provincial survey to every part of the British territories.

The memoir which accompanied these maps enumerates many curious facts very much at variance with the received opinions of the state, and early history of India; I will instance only a few of these.—The tribes occupying the mountain fastnesses and wilds, though distinguished by a variety of appellations, as Bheels, Coolees, Ramoosees, Mangs, Berads, Wuddars, &c., appear to have a common language with the natives of Gondwana, the Pendharees of the Vindhya range, and Telingana,—the mountaineers of the Girnar range, in Kattiawar,—the Todawurs and Kotars of the Nilgherries,—and the Bedahs of Travancore and Ceylon. This language has many words in common with the Teloogoo, and is remarkable as having a dual

number, indicative of greater refinement and antiquity than the existing vernacular languages of India. They have no Pantheistic worship; they acknowledge no deference to the prevailing institutions of the Hindoos; —they are simple, warlike, and migratory; —they have the ancient year of the Egyptians of 360 days, with the five days additional;—they observe the winter solstice, and some festivals unknown to the Hindoos;—they neither worship living objects, the sun, moon, nor other symbols,—neither do they venerate the Brahmin;—their history, in fact, points to a period of very remote antiquity, antecedent to the existing worship and settlement of India. Their neglected rights, through disregard of the successive ruling powers for many centuries, have given rise to the organized system of sanguinary and unparalleled murders, which have been perpetrated throughout the country with reckless impunity,—till of late they have roused the indignation of the British authorities in India. I allude to the execrable system of the Dakoits and Thugs.

To legislate for India without acknowledging their claim, or, in fact, taking the slightest account of the existence of this most ancient, and highly interesting, portion of the population of India, savours of negligence or indifference, if not of ignorance and injustice. It may perhaps be a question with some of you, what is the proportion they bear to the whole population of India, and what may be the aggregate numbers of this *aboriginal* population? I speak within bounds, certainly, when I say from two to three millions of souls,—in Kuttack, Khandesh, Kattiawar, Goojrat, Nagpoor, Hydrabad, the North Konkun, and South Malabar, they constitute two fifths of the entire population;—in Hindoosthan, the Deccan, Mysoor, the South Konkun, Kanara, Travancore, and the entire Carnatic,—they may amount to one tenth. I affirm

at least this much, that they are sufficiently numerous to entitle them to a place in our legislative provisions, certainly to bespeak the consideration of every friend of humanity, though they are excluded from the *benevolent* Code of the Hindoo. I say it would be highly desirable and important to see the numbers and situation of those *aboriginal tribes* denoted on a Statistical Map of India, as in the provincial Survey to which I have alluded.

I will add also another topic that these enquiries suggested, that the entire western coast has, from Cape Comorin to Kurachee, for upwards of eighteen centuries, been colonized by successive nations, Romans, Greeks, Persians, Arabians, Abyssinians, Africans, Jews, Armenians, Malays, Chinese, and lastly, by Europeans, by natives of Central Asia and Upper Hindoosthan,—so that it is not easy to discriminate, even amongst the existing castes and distinctions of the population, whence they are, and what their claims to priority, without residing among them for a very long time. These conclusions I have arrived at from a multitude of remarkable particulars which have fallen in my way in the researches I have made for many years, into the Chronology, History, Literature, and Arts, of the Hindoos. I am thus enabled to trace the steps of the Western nations, and their intercourse with the East; to recognize the overthrow of the Boodhist faith, shortly after the Birth of Christ; the conquest of the Jains, and the Brahmins; the supplanting and retreat of the Jains from Hindoosthan and Goojrat, to the Southern provinces of the Peninsula, about the sixth century after Christ; finally, the settlement of the Hindoo or Brahminical worship on its present basis,—nearly about the time of the introduction of Mohamedanism,—that is, about A. D. 607-8. The existence of Christian missions, and two Christian

bishops, on the Western coast of India, one settled at Kullian, in the Northern Konkun, the other in Travancore, in the first century after Christ: the settlement of a colony of Jews at various places on the coast, and in the interior;—of the Persians, followers of Zoroaster; of the Borahs, from the coast of Yemen, in Arabia; which last tribes had fled before their persecutors, the locust followers of Mohamedanism:—these, all, impart a singular interest to such Statistical enquiries.

I shall only mention one further instance of the utility of such investigations. It appears from the geographical distribution of plants that the existence of many species indicates the advantage with which their foreign congeners may be introduced and cultivated:—the coffee, for instance,—tobacco, various kinds of sugar cane, hemp, cotton, and indigo; maize, tapioca, arrow root, cardamoms, the leguminous plants of Europe, the potatoe, onion, and carrot:—It discourages also the culture of others,—the vine, the tea plant, opium, oats,—and on all the coast,—of wheat, barley, and flax. It points out the prodigious benefits to which a large variety of wild plants might be converted; not only in times of scarcity, but as a wholesome and nutritive substitute for deleterious, or a resource for scarcity of supplies of abundant, food in seasons of drought. The pith of the various Cycas,—the Elate Sylvestris;—a great variety of Scitamineous plants, such as the Curcuma, Alpinia, Canna,—several water plants, the Globba, the Nymphæa:—these, which are distributed with the most lavish profusion over vast tracts of mountain, fen, and wilderness, bespeak an indulgent consideration for such speculations. The principal Spice plants, for which we are now indebted to the Islands of the Malayan Archipelago, are indigenous on the slopes of that

mountainous region, which characterizes the western Table land of the Peninsula, and Hindoosthan. The Nutmeg attains a greater size throughout Kanara, Malabar, and Travancore, and, wherever it has been suffered to grow, in the Konkun also, than in the Malay Islands. Its produce, indeed, is comparatively scanty and poor; principally, because it is left to the innumerable birds and insects of the forests. The bread fruit, cinnamon, various kinds of pepper, cardamom, ginger, turmeric;—the orange, citron, lime, guava, mangosteen, mango, anacardium, and other fruits, available to domestic use;—escape the notice of the traveller, hurrying over vast tracts, where the noxious miasmata, engendered by an accumulation of decayed and rank vegetation, almost impenetrable to the sun's rays,—repress the most eager curiosity.

Let me pause here awhile, to pay a tribute of respect to two officers, who thus lost their lives,—and, but for which, we might now have had a better knowledge of these matters:—one, whose friendship I valued, no less than some, perhaps here present;—the amiable Turnbull Christie,—an accomplished Geologist, the pupil of Brogniart, Lyell, and Elie de Beaumont:—the other, Mr. Voysey,—whose rare qualifications, enthusiasm, and disposition, might claim a nobler eulogium. Mr. Christie fell a sacrifice to his zeal, by a fever contracted in the bamboo forests which encircle the Nilgherries. Mr. Voysey, by a like enterprise, in the interminable forests North of Nagpoor.—Captain Arthur in Malabar, Mr. Marshall, also, in the Southern Mharatta country, terminated a no less honourable career in these pursuits. Mr. Letchenault de la Tour, Col. Sykes, Baron Charles Hügel, Drs. Rottler, Roxburgh, Royle, Wight, and Wallich, have satisfied us that these occupations are not always fatal: certainly not unworthy the distinguished and munificent patronage they have re-

ceived from the East India Company. The works of Roxburgh and Wallich are allowed, on all hands, to be noble memorials of this munificence.

In regard to the general Survey of the remainder of the territories, under the Bombay Presidency, by Colonel Monier Williams, Captains Cruickshank and Ovans, they fall under the general definition of mere itineraries, and ordinary field surveys, executed, and for the most part laid down, without the slightest pretensions to scientific mathematical projection. Captains Drummond and Nutt, of the Engineers, the pupils of General Reynolds, did indeed, for a short time, give hope of some improvements,—but their services were withdrawn by the prevailing influence of those who deprecated scientific geography. The revenue surveys of Broach, Surat, Khera, and Ahmedabad, are in great detail, and accompanied with a variety of Statistical information. Having no connection however with the Trigonometrical and Topographical survey,—constructed, it must be confessed, without any regard to rigorous mathematical rules,—the charges incurred on this account have, in a measure, been most improvident and extravagant. An original document of this sort, though it be ever so well done, will, in process of time, be obliterated or much damaged in a public office in India,—considering it has frequently to pass into hands which take very little account of its real value, or the time, trouble, and cost of its execution. It may very reasonably be expected that unless such documents are printed,—and, unless they are well and scientifically completed, they are not worthy of it;—it may soon be expected that some, the greater part, nay perhaps all, will shortly disappear,—except only, when copies may be made, which must always be less perfect, less exact, and vastly more expensive. Even then, they are only accessible

to a few; and no large agricultural improvements, or great civil works, can be undertaken, to which they should properly call the attention of Government, and the Civil Authorities. We say nothing of disputed boundaries; of defining private and public property;—of assisting judicial decisions:—these, a correct ground plan ought to facilitate, if not to discourage and prevent litigation. These matters occur to my mind from a fact incidentally mentioned by Colonel Hodgson, formerly Revenue Surveyor General of Bengal,—that a considerable number of such surveys, made at that presidency, under his orders, were not now forthcoming in England:—and upon another authority, that in the settlement of some extensive landed property in Chittagong, enquiries were made in vain as to the site and nature of the estate in dispute. When we place these defects to the account of the large sums disbursed for such purposes,—sums certainly sufficient to have ensured as good and scientific a survey as the great Austrian Cadastre, or the Irish Survey,—had they been confided to the superintendance of professional Engineer officers, under the Surveyor General; I cannot but think it a measure deserving of the most serious consideration, in a financial, as well as in a prudential, point of view.

A work of this sort is public property, and ought to be so well ordered, carried out, and perpetuated, as to be generally available to the community. We have hitherto stopped short, supposing the object fulfilled, when the Manuscript Drafts are completed, and deposited in the Archives of the Government; but this were, indeed, a strange oversight of the value of the art of printing, to hazard the toil of years,—and the enormous sums expended in the preparation of such works, upon some one or two copies, subject to a thousand contingencies, to a fire, a robbery, to indi-

vidual negligence, malversation, or casualty of any sort. Provided such Surveys were generally useful, properly conducted, and accurately engraved, they could not fail of being in some demand:—at least, they would be more extensively available to the Government functionaries,—and if it were a matter of policy that any should not be published, or put into general circulation, it would be as easy to give effect to such intention, as to forbid copies being illicitly communicated. That is a weak Government, however, which is driven to such expedients. Capt. Burnes, whom I instructed in all the preparatory essentials of geography, told me that the Governor General took him aside, before he started on his expedition through Central Asia, and put into his hands Mouraviev's Journal,—the publication, or very existence of which, no doubt, the Russian Government had studiously interdicted, and concealed, as it at once unmasked the designs of that power; little imagining that it had found its way to the chief authority in India, despite of its utmost vigilance. Lord W. Bentinck, also, on his late visit to Paris, was surprised to find suspended at the Depôt de la Guerre a very complete Map of India, on which was indicated the disposition of the forces, and military posts, corrected to the latest date. Now, it is hardly credible in regard to this document, that it was drawn up from other than ordinary public sources of information, Registers, Public Journals, from materials, in fact, accessible to every one: yet both instances show how little the strictest policy can avail to secrecy: wherefore, it is obviously the better course to be independent of such indifferent securities, when injunctions to the observance of secrecy, may be defeated by sinister causes, beyond the reach of authority.

I will relate an anecdote which was communicated to me on the authority of one of the parties to whom the

subject was referred for opinion, of the genuineness of which I entertain no doubt. A foreigner, as it may be supposed, in the Russian service, brought to this country, and tendered for sale to the East India Company, a MSS. Map and Memoir of the interior of Central Asia, not far removed from the British possessions; either constructed, or purporting to have been made, by Klaproth, the celebrated Orientalist and Traveller, in the pay of Russia. Whether the price demanded was considered too high, that the information was not wanted, was scanty, or, which is most probable of all, that some one about the India House knew more of the real merits of the production, than the party, tendering it, had anticipated:—suffice it to say, it was declined for some reasons, and thereupon offered at the office of one of the Secretaries of State, and purchased for the British Government,—avowedly as a geographical work of considerable merit, and in a political view, of great importance. The contents were rigorously examined with other materials, and found to tally in some points with Klaproth's journals, though got up for the purpose of misleading the authorities in this country. Now what can prove the absurdity of locking up geographical information more than this, when the very Ministers of the Crown, when at least the Secretary of War,—who should best have provided for the protection and integrity of our Indian frontiers, were left at the mercy of foreign information, that might have been easily and better supplied by the professional Surveyors in India. At present, it must appear matter of surprise to find that the information, when thus collected by the Surveyor General, is either handed over to a person, quite independent of his control, to lithograph, Mr. Tassin in Calcutta; or is suffered to await the usual chances of destruction, to be as little appreciated as known, in some official repository. We

confidently believe this system will have an end, as it forms no part of the policy of the Directors of the East India Company, who have afforded those in search of such documents, the most prompt and liberal access.

The Surveys of the Bengal Presidency which have hitherto reached this country, are altogether of a much more imperfect nature; those only excepted by Majors Rennel, and Colvin, Lieutenants Boileau, and Buxton, of the Engineers, and Captain Wilcox. The Surveys of Bundelkund, and the Northern Sheets of the Atlas, bordering on the Himalaya range, have been unfortunately engraved before they have been adjusted to the great Trigonometrical Survey, and abound in inaccuracies. The *Vermicular illustrations*—designed to represent that magnificent and lofty chain, which separates our own possessions from those of China,—are *purely imaginary*;—a word to be received however, when applied to geographical embellishment, with some qualification. I add, with regret, that we have very few, and those most scanty, memoirs of all these surveys,—although it is well known they have been drawn up, and occasionally brought to light.

There is yet another subject on which I will briefly comment,—the preparation of Statistical, Revenue, Geological, and Geographical details, under so many separate superintendents. Is it, that it is more advisable, on the ground of economy, or of science? experience replies in the negative. It is decidedly inexpedient on every ground:—that which has to be done, should be done at the least expense, and it will be done at the least expense when all are carried on at one, and the same time, by parties competent to undertake them without distraction, or liability to be called off to other pursuits. The medical profession however well educated, have other pursuits, which i

properly attended to, are sufficient to engross all their time and energies. In all other countries, these duties have devolved, as a measure of economy and expediency, on the officers directing the surveys; such illustrative researches falling in, as a matter of course, with many others of daily professional observation, and considered essential to the descriptive memoirs. Such documents can neither be hoped for, nor attempted, without means; much less can they be expected of persons thus engaged, if taken from the service at large, without the aids of a scientific education. Comparing the result of Rennel's memoirs with the meagre details furnished by Dr. Buchanan, in the N. W. Provinces,—though the latter, according to the Indian mode of proceedure, cost 30,000 Rs. to compile, and the former entailed no expense beyond the usual official salary of the Surveyor General, it must be evident that such charges are extra-official, unnecessary, and unadvisable, as they divide and deteriorate from the general usefulness of Geography. If the officers of that Professional Arm, instructed at great charge, and with so much care, be set apart from the rest of the army, and entrusted, where there are no civil engineers, with the design and execution of all civil works,—either they are sufficient in numbers, and competent to such duties, or there should be an addition made to that body, and their competency provided for by better instruction. Practice makes perfect;—and I am persuaded there is neither want of intelligence, skill, nor integrity, in the corps of Engineers of the army of India:—considering the elèves are selected on the same principle as those of every other army throughout Europe, and, as far as the time allotted to their education will admit of it,—have the same opportunities and advantages of acquiring knowledge. It would be better indeed if some thought were given by the Home

authorities to the further detention and improvement of the younger officers of this useful body,—in Civil Engineering, including a knowledge of Steam Apparatus, Rail-roads, &c., Geology, Surveying, Astronomy, and Architecture,—similar to the system pursued in the Ecole Polytechnique, in France, where the junior officers of the Corps du Genie are kept to these studies till they are eminently proficient. Of this school were Carnot, Prony, Lacroix, Legendre, &c.

It was not till after a patient review of every circumstance which I have now placed before you, that I ventured to question how far we had neglected the necessary precautions, or been inattentive to the experience of our neighbours throughout Europe. When I was appointed to this responsible office, I acknowledged, as became me, my obligation to those who had conferred this honor on me, not without a resolution to shut my eyes to all private considerations, or personal convenience. I sought the best information I could get,—and after looking carefully into the systems pursued in France, Austria, Italy, Saxony, this country, and in Ireland, I came to the conclusion that the method practised in the latter is wonderfully calculated to fulfil all those desiderata which I have enumerated. Major Portlock, of the Engineers, is better able than I am, to explain the admirable process by which, to adopt Colonel Colby's own expression,—"a very large quantity of work is accomplished with the minimum of intellect," by which the labour is so subdivided and distributed, as to enable him with the aid of 200 Engineer soldiers,—under the direction of 20 officers of the Royal Engineers,—to survey, complete, and publish, 300 sheets, on an average, annually,—each sheet when engraved, calculated to contain 32,000 feet, by 21,000 feet. These soldiers were instructed and disciplined in the first instance, under Colonel

Pasley, of the Royal Engineers, at Chatham, and when thoroughly grounded in the elementary principles of Geometry, Surveying, and Plan Drawing, they were placed under the orders of Colonel Colby, and then divided off into squads, each under an officer. Colonel Colby directs the Triangulation, and superintends the whole;—Major Portlock has the direction of the Geological and Physical researches;—Lieutenant Larcom of the Engraving, Statistical, and Office details,—a laborious office which he has discharged with much advantage to the public service. The district officers have each some non-commissioned Engineers, with from 70 to 150 Civil assistants; and to each of the latter, work is portioned out, restricted to certain simple operations, gradually increasing in difficulty and responsibility, with the capability, practice, and trustworthiness of the parties:—the lowest in the scale merely measure lines with the chain, taking the offsets, and keeping a field book, as directed by the non-commissioned Engineers;—the party succeeding him, examines and inks in the work;—a third in succession computes the areas;—a fourth takes the levels;—a fifth computes and enters them on a Map. The officer breaks down the large triangulation to smaller triangles, and observes also the differences of level. It is the business of one of the officers to compute all these triangles and levels;—the non-commissioned Engineers break down the smaller triangles into others of the last degree, observing and computing the levels from those of the first,—and, in this complete net work, the stations for the final detail measurement are pointed out to those who have all the mechanical drudgery of the survey, as described above.

Such a system answers two great ends, economy and dispatch, but it fulfils a greater, in that it obviates collusion, or the exaction from any one individual of

the whole process, physical and mental; it relieves the officer of a thousand distracting, laborious, mechanical, details: it is a sort of Fellenburgh School of Industry, leading men on, by the certainty that nothing can be gained by negligence or fraud, to honest, hard labour,—to pursue with singlemindedness, fidelity, and cheerfulness, whatever is committed to each individual's capacity;—but the arrangements of the office details and the final engraving, which are carried on by the same admirable subdivision of labour, system, and regularity, bespeak for it the highest praise. Anything connected with any individual employed, or with any part of the Survey of Ireland, may be learnt at the office at Mountjoy in ten, or fifteen minutes:—where the work was done; by whom; with what kind of instruments; what the character of the parties; his field books; his rough drafts; &c. much more indeed, than can be here stated in this short summary. The arrangement of the whole of the documents of the Survey of Ireland is comprised in a fire proof room, 19 feet square; with extraordinary order, neatness, and convenience for immediate access. But there is a part of this work on which I must dwell more at length,—the Engraving. It would be useless to have such a Survey, if the final engraving were committed to any one unconcerned in its execution, or not deeply pledged to its accuracy. I say deeply pledged, because this is what the officer conducting every Survey will be, and I am sure no one else can so much be, as he is. Let it be considered for a moment, that the persons who conduct these national Surveys in Great Britain, Ireland, in France, Italy, Saxony, Russia, Austria, and other countries, are all officers of Engineers; or in the case of Hydrography, Naval Officers: Military Men, of great experience, bound by the sacred ties of Military allegiance to their corps, and country. In

whose fidelity, I ask, could the Government confide so safely, as that of such individuals? To their safe custody and prudence the documents are entrusted when prepared, as to their scientific acquirements, their zeal, and esprit de corps, the first preparation of the materials and the composition. In every single instance that I have here enumerated, the engraving is also committed as a no less sacred, I will even style it, a far more sacred trust, than any other. They are held responsible for the completion; they vouch for the authenticity of such documents by affixing the official stamp of their respective governments, as they pass through the press, and which cannot be effaced or removed without destroying the plans. The effect of such a system is to cheapen the work beyond belief; to permit of alterations and improvements, from time to time, as they may be desirable or necessary, yet they are not less free to the public.

In the Ordnance Survey, Col. Colby has introduced a curious process, which is peculiarly fitted to ensure a high degree of accuracy. The Principal Triangles being laid down, and their distances on the meridian and perpendicular being computed and set off, on a large diagram, a certain number of minor points established by the secondary Triangulation are determined, and fixed, in like manner, within the boundary of each parish or township; and the four points on the corners of each compartment for the respective sheets of the county Surveys, ascertained in like manner. These are then, at once, laid down on the copper, and the detached parish Surveys transferred to those fixed points; so that the edges of all the sheets fit exactly to each other when printed, and are not affected by the unequal contraction or expansion of the paper, which is the case in all ordinary maps; this, and many other improvements, are I believe exclusively due to

Colonel Colby; whose originality of mind has conferred a public benefit on this branch of the Service. Some men, as Mr. Babbage observed to me, have the talent of organizing matter, some of organizing mind; and this last, he considered to be Colby's fort. I would not be thought to disparage, or overlook the merit of others: of Colonel Pasley, who first instituted this admirable system of instruction; of Lieut. Drummond, Col. Reid, and other officers: but I think it a matter of regret, and it will be of reproach to us, if the Corps in India, does not do its best endeavour to compete with that in Her Majesty's Service. We have had many highly distinguished in the field, Anburey, Warlowe, Davis, Nattes, Purton, Lake, Johnson, Remon, and G. Jervis. We have had others equally ingenious as Civil Engineers, Forbes, Hawkins, Hutchinson, DeHavilland, Blane, Mc. Gillivray, Cotton, and W. Cowper; as Architects we have Kyd, Robins, T. Cowper, Russell, and Waddington, and a host of others. Our Geographers were Rennel, Reuben Burrowes, Mackenzie, and many whose names I have already enumerated. It were strange indeed, if in any requisite, that were essential to the management or engraving of the most extensive Survey in the world, we, only, should be found deficient: and I know of no drawback to this, but the preponderating influence of those, who either do not see so far as we do, into the true interests and wants of India, or who lean to their own, from an apprehension that the delegation of such duties will detract from their own consequence, or in any way operate to their prejudice. For myself I think it never can, and I find the first artists ridicule the idea, that engraving cannot be carried on as well, or even better, in India, than here, when we call to mind, that the finest engravings in the world have been produced in Italy, under as bright a sky, and as high a temperature.

Whatever may be the intentions of the British Government with respect to the amelioration of India, and it cannot be doubted that they are, on the main, of a liberal and wise nature; no improvements in the construction of roads, canals, embankments, public edifices, in short, any thing calculated to draw out and improve the resources of the country, can possibly be undertaken, or even made intelligible, without a very exact survey on a large scale, nor without the publicity and widest circulation of such survey. A very great progress has been made in the scientific net work, on which to ground such survey; and with the aids, placed at my disposal,—upon the *full* adoption of the suggestions which I have submitted to the Home authorities, and those which have likewise been made by the scientific men in this country, who can have no prejudice, or leaning of any sort, to any particular individual, system or object, I believe the Topographical Survey of British India might be brought to a close in about seven years;—accompanied with very complete, and useful, illustrative memoirs, for which there are even now a large quantity of materials available. To accomplish this, however, one and all of those experienced persons whom I have consulted, consider the confidence of the Government as indispensable to success, as the entire, and sole, conduct of the compilation, and engraving, to the final accuracy.

Conversing some time back with a gentleman of the civil service, of acknowledged ability and experience, he observed, "After thirty-eight years residence in India, I confess we know comparatively nothing of the country, and still less of the native character and institutions." Nor was he singular in this opinion,—Sir Thomas Munro, adverting to the great question of improving the condition of that Empire, thus succinctly points out the necessity and the advantage

of a comprehensive and accurate revenue survey,—"An Agricultural Survey of the country should be made, in order the better to ascertain its resources, and to establish a fixed and moderate assessment: I am satisfied that this measure alone would be more effectual than all other measures combined, in promoting the improvement of the country, and of the people. But before we can lower the land revenue, to the best advantage, we ought to know clearly what it is we are giving up. The information requisite for this purpose can only be obtained from *an accurate survey of each province*.—Our great error in this country, during a long course of years, has been too much precipitation in attempting to better the condition of the people, with hardly any knowledge of the means by which it was to be accomplished; and, indeed, without seeming to think that any other than good intentions were necessary. It is a dangerous system of government, in a country of which our knowledge is very imperfect, to be constantly urged by the desire of settling every thing permanently: to do every thing in a hurry, and in consequence, wrong; and in our zeal for permanency, to put the remedy out of our reach."

We hear of famines, of insurrections, of superstitious and barbarous rites: and are surprised that they should find any place under the milder exercise of the British sway. To obviate, or alleviate, these evils there is one plain course before us, to know more of the country and of the people;—improving that knowledge to their benefit, and to our own honor. This will engender attachment, though in a conquered country; this will confer stability, though that acquaintance supersede the terror of the sword. If it were all well with India and ourselves; if additional wealth flowed in upon every fresh accession of territory; if every

enlargement of our frontiers brought us in contact with new tribes, ready to acquiesce in our supremacy, to welcome us with open arms; we might administer the sovereignty without distraction or anxiety: but if the neglect of every precaution, the disregard of every improvement, entails a corresponding embarrassment on the Colony, and on the Mother country; if it weakens our hold on the opinion of the natives, and detracts from the reputation and interests of the state; we may hereafter revert with shame to that long interval of peace, when so much might have been accomplished, to acquire knowledge, to ensure co-operation,—to repel aggression, and to establish a durable and solid memorial of a peaceable and provident Government. I am quite sure that the first effectual advance towards this happy consummation of good Goverment, is to look narrowly into the extent, capabilities, and resources of that country; an accurate Survey, conducted on the principles I have so fully explained, affords a satisfactory key to the former; good memoirs furnish whatever else is desirable: nothing is now wanting to this measure, as regards India, but the concurrence of the Home authorities. They have every information before them, and officers ready to give effect to their orders. I should be very slow to counsel such measure on my own judgment, or the little experience I may be supposed to have:—yet I confess I feel some interest in the fortunes of a country where I, and my father, and my children, drew our first breath; where so many members of my family have passed their lives for *upwards of a century*, associated with a great variety of persons in every walk of life, whose excellent qualities would have done honor to any country.

From what I have stated, you will perceive it is not without reason, or experience, that I have contended for the necessity of many and great improve-

ments in India,—and I do so, both as a friend to science, and an enthusiast in the cultivation of it; yet still more so, as I am reponsible to my country, and profession, for the upright and due discharge of my duty. Economy is the nerve of science, and the public service: he who is prodigal of his time, or his energies, is as great a spendthrift as he who is prodigal of other possessions. I strongly plead, therefore, for the best description of materials we can get,—the best machinery,—and the best workmanship. If Surveys are undertaken by authority from Government, they should invariably be accompanied by a memoir, explanatory of their construction;—and such other descriptive memoirs, as the time and talent of the individuals employed, may admit of; that is, Geological, Descriptive, and Statistical Memoirs. I would insist on the parties being fully qualified for such undertakings, and that it should be optional with the Government to publish all the results of their Surveys:—otherwise, I would leave the parties free to publish for their own benefit, at their own charge. I would leave it exclusively with the Directors of such undertakings to recommend the parties for such service,—to select their instruments, form their plans; entrusting them with full powers to arrange, as to the orthography, system, expression, scale, engraving, and, in fine, all other minor details; a course which would ensure, what has been always felt as the greatest desideratum in Geography,—a uniform and intelligible view of the surface, divisions, physical character, and statistical aspect of countries, widely removed, probably, in many respects also, very dissimilar to each other. We should then do for this neglected science, what the Royal Geographical Society was especially contemplated to accomplish, a very great and most honorable public service to our own country, and to the world at large.

T. B. JERVIS.

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No. 1.

From Captain W. A. TATE, late of the Corps of Engineers, Bombay, and for about fourteen years employed on the Revenue Survey of the Islands of Bombay and Salsette,—in reply to Major JERVIS' reference to him, as to the share which the natives of India had in the actual measurement, plotting, and drawing of those Surveys, and their general capacity and fitness for such offices. More particularly also, as to the applicability of Colonel COLBY's System, as pursued in Ireland, to the promotion of dispatch and economy in India.

East Harptree, September 12th, 1838.

My dear Jervis,

I received your Letter only two days ago, and now take the earliest opportunity of replying most gladly to it, and giving you my sentiments on the subjects contained therein, according to your request. Though several years have elapsed since I was engaged in that very interesting Branch of our profession which must now occupy much of your attention, yet, believe me, I do not feel the less concern for the promotion of Science in India, and especially of that Branch in which I had so much experience and labor for many years of my life; and therefore shall be much gratified in affording you all the information in my power on the subjects referred to in your Letter. In the first place, I must say, I heartily agree, from my own personal observation and experience, to what you have represented to the Court of Directors, viz. That the Natives of India, (especially the Hindoos) if properly instructed and disciplined by Engineer Officers, might be brought to

such Proficiency and Skill, in the various Branches of Surveying, even from the capacity of a Chain Measurer to that of an accurate Observer with the Theodolite, as well as of a neat Draughtsman, as very considerably to abridge the personable labour and fatigue of European Officers, especially in such a climate as that of India, which I can truly affirm *to my own cost*, is such as to render great exertion in the out of doors' duties of the Surveyor, most prejudicial to the European constitution; it was this that impaired mine, and rendering me quite unfit to resume my Professional duties in India, reduced me to the painful necessity of retiring from the Service on *Half-Pay*, and thus at once relinquishing all prospects of obtaining a competency in that service for myself and family: I merely mention my own case as one that may be useful to you, in strengthening your argument and position, about the employment of the Natives of India with *very great advantage* in most respects, in the various duties of Surveyors in their own Climate and Country. But now as respects my own experience as to their co-operation with me:—In the first place, as to the three large plans, of Bombay and Salsette, which I presented to the Court some years ago, they were wholly executed in this country with my own hand, but were compiled from data, (that is outline copies, in small detached Sheets,) of the *Finished Plans which my Native Surveyors and Draughtsmen drew in Bombay under my superintendance.* These Surveyors and Draughtsmen I myself instructed, and *to such an extent of proficiency as to enable me to confide several portions of the work to them, and this was effected without any aid from Europeans;* It is true that at one period, Government appointed two Infantry Officers as my Assistants, viz. one for Bombay, and one for Salsette; but I had all the trouble of instructing them

in Surveying and Drawing, and I have no doubt you will heartily agree with me, in thinking that there must have been more trouble to do so than to instruct the Natives, for many reasons, which it is needless for me to enter into. Suffice it to say, that I was well pleased when Government required their services for Regimental duties, and I was permitted to employ and instruct *any number of Natives* I required, to assist me in the completion of my two Surveys of Bombay and Salsette: *this instruction was of course for some time a hindrance to the work being completed as soon as it would otherwise have been;* nevertheless, I reaped the fruits of my labour hereafter, for by the assistance of several *Parties* of Surveyors, the work was extended to different Villages, and Townships, &c. at the same time, and the two Surveys were then *rapidly* brought to a close, the original Plots completed, the Areas of landed estates, &c. completed, and the first plans drawn for Government; the latter by *separate Draughtsmen,* who had not been instructed in Surveying, but *only* in drawing Fair Copies of the original plots executed by the Surveyors. The Plans I myself executed in England, were *copies of those in India,* but on a smaller scale; and intended solely to accompany my Statistical, and Topographical Reports, for the Court. This brief summary of my labors in the Surveys of Bombay and Salsette, will probably suffice to strengthen your argument on the great benefit to be derived from the employment of the Natives of India, in the various branches of Surveying. Had such a system been adopted some years previously, my own health and constitution might, humanly speaking, have been preserved to this day for the Service of the Company, and *the two Surveys of Bombay and Salsette might have been completed in less than half the time;* and perhaps *at one fourth of the expence;* and certainly

therefore much more to my own credit, and that of the Corps to which I had the honor of belonging. Surely this simple statement of facts which you are at liberty to make any *Public* or *Private use* of, may be considered a sufficient ground for at least trying the experiment with the Natives, upon a similar system with the Ordnance Survey; and I will be bound to affirm, that if you, as Surveyor General, should have an adequate number of efficient Engineer Officers, under your orders, to superintend the different portions of the Survey of India, and under their controul, a sufficient number of Natives well instructed and disciplined in the different *minutiæ* of the work, each Native having his own distinct duty, the result would be Expedition, Accuracy, and Economy in the end. The labors of out of doors' work is certainly much more calculated for Natives than for Europeans, and as for the mechanical parts of the Plan Drawing which of course requires more patience and assiduity than mental skill, I will be bound to say, without any wish to take praise or credit to myself, that my Native Draughtsmen would compete with most Europeans in India: I therefore from past experience, differ from Mr. Walker in the sentiments you say he has expressed; nor can I consider him to be any judge of this matter, as I believe he was never in India at all. I also fully agree with you "that every Survey that is not conducted upon Scientific Principles, is absolute *waste* of *time*, *money*, and *public life*;" hence, therefore, speaking without any undue partiality to my own Corps, the great advantage of always employing Engineer Officers on Surveys, which I consider to be as essential a branch of their Profession, as manœuvering a Regiment is that of an Infantry or Cavalry Officer.

It appears to me from what I have heard of Col.

Colby's system in the Ordnance Survey, from two of my Pupils, Messrs. Strickland & Reynolds, (who were employed for a while on it,) that it is one which is quite as much, if not more suited to the Natives of India, who have I think, generally speaking, *more of a Mechanical disposition* than Europeans, and who would not feel so much *degraded* by having *distinct minute portions* of the work confided to their execution, instead of having their minds occupied with more extensive pursuits: I think you will agree with me in this testimony of the Native Character. And the statement you have given me in your Letter of the System in the Irish Survey, is quite sufficient to bring me to this conclusion, *that it is the very System suited to the Natives of India*; and my knowledge of them leads me to say, *Instruct them well, be patient with them, and not go beyond their mental capacities, shew them kindness, as well as firmness and consistency, and you may, I am sure, place as much confidence in them as in Engineers, and perhaps much more.* They require but comparatively low Salaries, for their wants are comparatively little: I have found them obedient, submissive, and faithful Servants: and should you ever fall in with any of my poor Surveyors and Draughtsmen, pray enlist them, if disengaged, into your Service: the Letters I have received from them prove their affection for me; and that they are not unmindful of my labors in their instruction.

I will now close this, and if you require any more information from me, pray let me know, and I shall have much pleasure in communicating it.

I remain, my dear Jervis,

Your very sincere Friend,

WM. A. TATE.

No. 2.

Extract from a Memoir of the late DAVID SCOTT, Esq., Agent to the Governor General on the North East Frontier of Bengal, and Commissioner of Revenue and Circuit in Assam.—Printed at Calcutta, 1832.—Shewing, on the authority of one of the ablest and most experienced Servants of the E. I. Company, the applicability of the principle of the subdivision of labour, similar to that advocated by Colonel COLBY, as pursued in Ireland, to the promotion of dispatch and economy in the Survey of India.

The late Mr. DAVID SCOTT's extraordinary merits and services were considered such, as to entitle him to a public Monument, an honor which was only once before accorded by the Governor General of India, in Council, to the memory of the benevolent CLEAVELAND.

"Being anxious (for Revenue purposes) to ascertain, as speedily as possible, the exact resources of the country, Mr. Scott proposed to Government, and obtained a Survey upon, I believe, quite a new principle, in Bengal. The work was almost entirely performed by native Surveyors, Bengalees or Assamees. The European Surveyor, or his Assistant, marked out the given tract, and surveyed the boundary. The interior portion of the area was entirely filled up by native surveyors, and protracted by the European surveyor, or his assistant. So many native surveyors being employed upon very small salaries, if their work was performed in an efficient manner, it is clear that a survey would be accomplished at much less expense, and with more despatch also, than under the present mode. But the nature of the country and its unhealthiness opposed serious obstacles; most of the sur-

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veyors were Bengalees, who suffered severely from sickness; and thereby the work has been somewhat retarded. The work was very ably superintended by the late Lieut. Bedingfield, of the Artillery; and the conduct of it under Mr. Matthews, the present surveyor, afforded Mr. Scott every satisfaction. Mr. Scott himself had considerable experience as a practical surveyor, and was capable of throwing out very useful suggestions for the management of the survey.

Mr. Scott took much interest in the progress of geographical discovery on the North East frontier; and, on his application to Government, I believe, those arduous expeditions were undertaken, in which Lieutenants Wilcox and Burlton were employed. It was a matter of much regret to him, that circumstances deprived him of the services of these valuable officers, in this honorable but dangerous career."

No. 3.

At a General Committee of Recommendations of the British Association for the Advancement of Science, held at Newcastle on Tyne, Saturday, 27th August, 1838,—His Grace the Duke of Northumberland, President.—Sir Charles Lemon, Bart., M.P., in the Chair.

Resolved—That the British Association regard the measurement of an arc of longitude in India, comparable in extent to the Meridional arc already measured in that Country, as a most important contribution to other facts illustrative of the Earth's true figure, and by a necessary consequence to the progress of Astronomy.—That the verification and comparison of the Standards of the Indian and English Surveys, as compared with the proposed Parliamentary Standards, is indispensable to the correct knowledge of the meridional and parallel arcs.—That pendulum observations at the principal elevations or contiguous plains, and on the Sea Coast, if possible on the same parallels of latitude, will afford results of great value to physical science.—That observations for the determination of the laws of refraction in the elevated region of the Himalayas, and at the observatories of Madras and Bombay, will be a most important service to science.—That it is highly desirable also that Magnetical observations should be made in India similar to those which are carrying on in other parts of the world, and which are justly regarded with so much interest.—That a topographical map of India upon a large scale, accompanied by Statistical and Geological information, would be highly desirable.—That the Association is desirous of bringing the high scientific importance of these undertakings under the consideration of the East India Company.

Signed, NORTHUMBERLAND.

NO. 4.

Copy of a Letter from Captain F. BEAUFORT, R.N., Hydrographer to the Admiralty, to Major T. B. JERVIS, in reply to a reference as to the course pursued by the British Government, in the selection and appointment of Naval Officers, and others, in the Government Nautical Surveys; as well as his opinion of the merits of the compilation and engraving of the Surveys of India, and how far it appeared to him judicious to defer the engraving to the Surveyor General.

DEAR SIR,

In answer to your questions, I can first most decidedly say, from all the experience I have had, that it would be perfectly impracticable to conduct any great Survey with accuracy, or with economy, and in any reasonable time, unless the selection, as well as the continuation of every individual employed in it, were to depend altogether on him who may have the charge of the whole work. If he is to be responsible for its due execution, he alone must have the choice of the tools; and in point of fact, such has invariably been the case in the Admiralty Surveys. In no single instance have their Lordships ever interfered, directly, or indirectly, with the appointments, the movements, or the discharge of any Officer in this branch of the service. Their confidence may indeed be erroneously placed; but I am satisfied till that be altogether withdrawn, they will not stultify the only means that can be given to me of accomplishing the results which they desire.

And if that entire confidence be necessary *here*, in order to ensure unity of action, and cheerful subordination, how much more so in a vast country like India, where many branches of the work must be so remote

from head quarters; where various talents may be adapted to various parts of it, and where there may be so many jarring interests and personal jealousies to reconcile.

I cannot reply to your second question quite so categorically, because I have not seen the materials from which that great Map has been constructed. I can only judge by its appearance; there are however, in any extensive work, certain points of internal evidence by which it may be tried, and I fear I must say in the work in question, they do not speak in its favour; but besides my own opinion, I may quote that of a very intelligent person resident in the North of India, who writes in no very flattering terms of its merits. Most probably it may turn out, that the many hands through which this Map has passed, have been the cause of its failure; and you will hereafter find, when you are actively employed in the great enterprize, to which I understand you are appointed; that surveying and mapping are two distinct things, that the science and skill requisite for the geodesical operations, are qualities of a different cast, from the taste and judgment, necessary for combining and preparing them for publication, and that in such a great enterprize as the Survey of India, both those branches of it must be under the controul of one head.

I am,

DEAR SIR,

Yours very truly,

Signed, F. BEAUFORT.

No. 5.

Copy of a Letter from Colonel COLBY, R. Engineers, Superintendent of the great Trigonometrical and Topographical Survey of Great Britain and Ireland, to Major T. B. JERVIS, in reply to a reference as to the course pursued by Government, and the Master General of the Ordnance, in the appointment of the Officers, and others, and the degree of confidence placed in him.

Ordnance Map Office, Tower,
20th June, 1838.

My Dear Sir,

In reply to your question respecting the course taken by the Master General of the Ordnance in the appointment of officers and others to be employed under my command on the Survey of Ireland; I have to inform you, that Survey was undertaken when the Duke of Wellington was Master General of the Ordnance, and that he, considering me responsible for the success of that great undertaking, confided the selection of all the officers and other persons, to be employed, to me, with full powers to relieve the Survey of all those who might not be found eligible for that duty, by a simple expression of my wishes to the Inspector General of Fortifications. This power still continues, and is absolutely essential to the success of the Survey.

The Military are necessarily under the usual military regulations, and return to other duties when they cease to be employed on the Survey. But the Civilians who are hired by those under my direction to perform various duties on the Survey, are not appointed by the higher authorities, and they are at full liberty to quit the Survey, whenever they can obtain any more eligible situation. They may therefore also be removed

by me, whenever their services are no longer advantageous to the Survey.

The Soldiers and Civilians are rewarded by me with successive advances of pay, according to the quantity and quality of the work they perform. *Without such full confidence and powers being given to the superintendent, it would be impossible to carry forward any extensive work at a moderate cost.* It may perhaps be necessary to guard you against one source of additional cost and trouble which operated at the commencement of the Survey of Ireland; and which will always operate in some degree against all training establishments. There are many departments which depend for their assistance upon persons trained elsewhere. These departments necessarily pay very high prices; and the high prices they pay, will attract many assistants from those departments which train for themselves.

When this opposition arises only from small departments, the demand is soon supplied, and the evil ceases; as I have found on the Irish Survey. But if a Government are upholding great rival departments, of such a description, the cost of training, if confined to one alone, would be excessive. I would therefore to prevent such an expensive competition, in the outset, recommend you to undertake the charge of all such Surveys which may be in progress in India. You would then be able to reward your most meritorious assistants, by placing them in the most advantageous situations, and thus stimulate exertion without any extra cost, and on the whole effect a great public saving.

I remain,
My Dear Sir,
Yours very truly,
Signed, THOMAS C[illegible]

No. 6.

Extract from the late Colonel Wm. LAMBTON's last Report, in 1822, *relative to certain physical enquiries connected with the great Survey of India.*

"Having now surmounted all difficulties which this desolated country presented, I hope I shall move on more rapidly, particularly as I shall confine myself to a single series of triangles, running in a meridional direction. I wish with all my heart that a series along each coast could be carried on at the same time. There would then be the axis and the outlines of a skeleton which might be filled up in after times. But as my present means are not competent to that, I must do the needful in the next degree. I shall therefore in the first instance employ my chief assistant in commencing from a side on the meridional series, somewhere between the latitudes of 18° and 19°, and thence proceeding westward so as to take in Poona, and finally fix the position of Bombay. That being completed, the coast operations may then commence in the Masulipatam district, and be carried through the Northern Circars, fixing the positions in latitude and longitude, of every seaport along the coast, as far as Point Palmiras, with Calcutta. I say, if possible, because every means should be tried to accomplish so important an object; and I have no doubt that by the erection of beacons and other artificial means, the position of Saugur Island might be determined, and thence a series of small triangles might be carried up the Hoogly, so that a connection between Bombay and Calcutta might be completely effected, and their difference of longitude determined by Geodetical measurement:—a most desirable object should it ever be the intention to have corresponding astronomical observations made at these two places. The establishment of observations at the almost extreme points in longitude of our Indian Empire would, in this age of astronomical science, be worthy the consideration of a liberal and enlightened Government.

Having said so much as to the geographic[illegible] and astronomical purposes to which this survey may be applied, I shall add a few observations respecting other great scientific objects, connected with it, and to which my own attention has been, and will continue to be, most particularly directed.—The immediate end of the grand operations carried through France and Spain, by the celebrated De Lambre and Mechain, was the measurement of an Arc, on the Meridian, from which to deduce the figure and magnitude of the Earth, in order to obtain a general standard measure; and for this purpose they divided the quadrantal arc of the elliptical meridian by 10,000,000 and called that the metre. From these results it appears that their metre is 39.371 English inches reduced to our standard temperature of 62° Fahrenheit. It has been my endeavour, in bringing up my meridian arc, to adopt every possible means to ensure accuracy, so that when my measurement should be compared with theirs, with the English, and with the Swedish measurements, the length of the metre might be deduced from all these comparisons. Previous, however, to drawing any final conclusion, it may be necessary to observe that a standard scale has been recommended to His Majesty by the Commissioners for weights and measures, and will doubtless be adopted by Parliament. This scale agrees with the one with which the French metre was formerly compared: but differs both from Ramsden's standard by which the English measurements were made; and from the brass standard from which my standard scale was laid off; and it appears from a course of very judicious and accurate comparisons of all the different standards with my standard, that Ramsden's standard will require a correction of +,00097 multiplied by its own length; and that mine will require a correction of −,000018 multiplied by *its* own length, to reduce them to the Parliamentary standards. Having corrected the whole of my meridional arc from Cape Comorin to Daumergidda, in latitude 18° 4′ nearly, by the above factors, I have brought out the metre 39.3677 English inches at the temperature of 62° which only differs from the French Metre 0032 inches when reduced to the same temperature; a quantity altogether insensible.—A short paper giving an account of these corrections and reductions has been sent to the Royal Society, and will probably appear in the Philosophical Transactions for the present year.

Besides the measurements of the different arcs, the French and English Mathematicians, in conjunction, have made a series of experiments with pendulums, at all the great stations of observation, from the Isle of Unst, the Northernmost of the Shetland Islands, to the Isle of Wight; and the French and Spanish Mathematicians have made similar experiments from Dunkirk to Formentara, in the Island of Minorca. If I reach Agra, the place where I expect my Meridian line will cross the Jumna, the amplitude of my arc will be nearly as great as from Unst to Formentara; and should time and circumstances be favourable, there will be great inducement to use the pendulum at all the great stations from Agra to Cape Comorin; and if corresponding observations can be made at the same latitudes on the sea coast, some very important results may be obtained with respect to the geology of the Peninsula, by comparing the ratio of the second's pendulum at the different heights above the sea, to the ratio in the same latitudes on the sea coast.

There is another weighty matter, which falls within the province of whoever may conduct a work like this; and it will draw my particular attention, should I live, and circumstances prove favourable; that is,—the subject of celestial and terrestrial refraction. The first is of high importance in practical astronomy and navigation, and the latter in determining the elevations and depressions of mountains and stations above the level of the sea. The theory of celestial refraction has been physically considered by the first mathematicians of the age; but the want of data has left uncertainty in their several conclusions. To furnish such data, the horizontal refraction, and the refraction at 45° of latitude should be determined by actual observation, beginning at the sea coast, and observing at one, two, &c. to six or seven thousand feet above the level of the sea; and if these observations can be made in the same latitude, it will be still more satisfactory. These experiments will shew whether there be any regular law of change, in ascending to the higher strata of the atmosphere; and will also give data for determining the refraction at every other altitude from 0° to 45° and from 45° to 90° above the horizon. This is an enquiry deserving of the greatest attention, and I shall feel highly gratified, if in the course of my labours, I may be able to throw any new light upon the subject.

Various other scientific subjects might be brought within the range of this work, particularly the attraction of mountains. But the difficulty of finding suitable ones for the experiments would take up much time, and, perhaps, after all, the attempt might fail. I shall, therefore, confine my views to what I have already mentioned, in order that something may be rendered complete, before I relinquish this laborious, but yet interesting work; for ere long it must be my wish to bring it towards a conclusion. It is now upwards of twenty years since I commenced it on this great scale. These years, I may venture to say, have been devoted with unremitted zeal to the cause of science: and if the learned world be satisfied that I have been successful in promoting its interests, *that* will constitute my greatest reward. In this long period of time, a considerable portion of the life of man, I have scarcely experienced a heavy hour; such is the case when the human mind is absorbed in pursuits, that call its powers into action:—a man so engaged, his time passes on, insensibly; and, if his efforts are successful, his reward is great; and a retrospect of his labours will afford him an endless gratification. If such should be my lot, I shall close my career with heartfelt satisfaction, and look back with unceasing delight on the years I have passed in India."

Signed, W. LAMBTON.

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